

**PCT** 

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

- (51) International Patent Classification 6: C07D 207/00, 401/00, C07K 5/00
- (11) International Publication Number:

WO 98/19998

(43) International Publication Date:

14 May 1998 (14.05.98)

(21) International Application Number:

PCT/EP97/06125

A2

(22) International Filing Date:

5 November 1997 (05.11.97)

(30) Priority Data:

08/746,295

7 November 1996 (07.11.96)

US

- (71) Applicant (for all designated States except US): NOVARTIS AG [CH/CH]; Schwarzwaldallee 215, CH-4058 Basel (CH).
- (72) Inventor; and (75) Inventor/Applicant (for US only): VILLHAUER, Edwin, Bernard [US/US]; 20 Dorothy Drive, Morristown, NJ 07960 (US).
- (74) Agent: ROTH, Bernhard, M.; Novartis AG, Patent- und Markenabteilung, Lichtstrasse 35, CH-4002 Basel (CH).
- (81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DB, DK, EE, ES, FI, GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SB), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

#### Published

Without international search report and to be republished upon receipt of that report.

- (54) Tille: N-SUBSTITUTED 2-CYANOPYRROLIDINES
- (57) Abstract

N-(N'-substituted glycyl)-2-cyanopyrrolidines, e.g. compounds of formula (I) wherein R has various significances, are novel. They inhibit DPP-IV (dipeptidyl-peptidase-IV) activity. They are therefore indicated for use as pharmaceuticals in inhibiting DPP-IV and in the treatment of conditions mediated by DPP-IV, such as non-insulin-dependent diabetes mellitus, arthritis, obesity, osteoporosis and further conditions of Impaired glucose tolerance.









## FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL AM AT AU AZ BB BB BB BC CC CC CC CC CC CC CC CC CC	Albania Amenia Australia Australia Azerbeijan Bomia and Herzegovina Barbados Belgiam Burkha Paso Bulgaria Benin Brazil Belarus Cenada Central African Republic Congo Switzerland Côto d'Ivolro Cameroon China Cuba Czech Republic Gernany Deamark Estonia	ES FI FR GA GB GH GN GR HU IB IL IS FT FR KE KG KP KR LL LL LL LL LL LL	Spain Finland Pranca Gabon United Kingdora Georgia Ghana Guinea Orecce Hungary Ireland Iarnel Iceland Italy Japan Kenya Kyngyzatan Democratic People'a Republic of Korea Republic of Korea Resakatas Saint Locia Licchtenatela Sri Lacka Liberia	LS LT LU LV MC MD MG MK ML MN MR MV MX NB NL NO NZ PL FT RO RU SD SE SG	Lesotho Lithuania Luxembourg Latvia Monaco Republic of Moldova Madagascar The fornor Yugoslav Republic of Macedonia Mali Mongolia Mauritania Malawi Mexico Niger Netherlands Norway New Zealand Polsmd Portugal Romania Russian Federation Sudan Sweden Singapore	SI SK SN SZ TD TG TI TR TI US US US VN YU ZW	Slovenia Slovenia Scengal Swaziland Chad Togo Tajikistan Turkny Trisidad and Tobego Ukraine Ugunda Unleed States of America Utbekistan Yugoslavis Zimbabwe	
---	---	---	--	---	---	--	--	--







### N-SUBSTITUTED 2-CYANOPYRROLIDINES

### <u>Field</u>

The present invention relates to N-substituted 2-cyanopyrrolidines. More particularly, it provides novel N-glycyl-2-cyanopyrrolidine derivatives.

### **Background**

Dipeptidyl peptidase-IV (DPP-IV) is a serine protease which cleaves N-terminal dipeptides from a peptide chain containing, preferably, a proline residue in the penultimate position. Although the biological role of DPP-IV in mammalian systems has not been completely established, it is believed to play an important role in neuropeptide metabolism, T-cell activation, attachment of cancer cells to the endothelium and the entry of HIV into lymphoid cells. DPP-IV is responsible for inactivating glucagon-like peptide-1 (GLP-1). More particularly, DPP-IV cleaves the amino-terminal His-Ala dipeptide of GLP-1, generating a GLP-1 receptor antagonist, and thereby shortens the physiological response to GLP-1. Since the half-life for DPP-IV cleavage is much shorter than the half-life for removal of GLP-1 from circulation, a significant increase in GLP-1 bioactivity (5- to 10-fold) is anticipated from DPP-IV inhibition. Since GLP-1 is a major stimulator of pancreatic insulin secretion and has direct beneficial effects on glucose disposal, DPP-IV inhibition appears to represent an attractive approach for treating non-insulin-dependent diabetes mellitus (NIDDM).

Although a number of DPP-IV inhibitors have been described, all have limitations relating to potency, stability or toxicity. Accordingly, a great need exists for novel DPP-IV inhibitors which are useful in treating conditions mediated by DPP-IV inhibition and which do not suffer from the above-mentioned limitations.





ODOG:



PCT/EP97/06125

WO 98/19998

-2-

### Summary of the invention

The invention provides novel N-(N'-substituted glycyl)-2-cyanopyrrolidines which are effective as DPP-IV inhibitors in treating conditions mediated by DPP-IV. It also concerns corresponding pharmaceutical compositions, a process for their preparation, a method of inhibiting DPP-IV comprising administering to a patient in need of such treatment a therapeutically effective amount thereof, the compounds for use as a pharmaceutical, and their use in a process for the preparation of a medicament for treating a condition mediated by DPP-IV.

### Detailed description

The invention concerns N-(N'-substituted glycyl)-2-cyanopyrrolidines, hereinafter briefly named "the compounds of the invention"; more particularly, it concerns compounds of formula I:

wherein R is:

a) R<sub>1</sub>R<sub>1a</sub>N(CH<sub>2</sub>)<sub>m</sub>- wherein

 $R_1$  is a pyridinyl or pyrimidinyl moiety optionally mono- or independently disubstituted with  $(C_1 \triangleleft)$  alkyl,  $(C_1 \triangleleft)$  alkoxy, halogen, trifluoromethyl, cyano or nitro; or phenyl optionally mono- or independently disubstituted with  $(C_1 \triangleleft)$  alkyl,  $(C_1 \triangleleft)$  alkoxy or halogen;

 $R_{1a}$  is hydrogen or  $(C_{1a})$ alkyl; and m is 2 or 3;

- b) (C3-12)cycloalkyl optionally monosubstituted in the 1-position with (C1.3)hydroxyalkyl;
- c) R<sub>2</sub>(CH<sub>2</sub>)<sub>n</sub>- wherein either

R<sub>2</sub> is phenyl optionally mono- or independently di- or independently trisubstituted with (C<sub>1-4</sub>)alkyl, (C<sub>1-4</sub>)alkoxy, halogen or phenylthio optionally monosubstituted in the phenyl ring with hydroxymethyl; or is (C<sub>1-4</sub>)alkyl; a [3.1.1]bicyclic carbocyclic moiety optionally mono- or plurisubstituted with (C<sub>1-8</sub>)alkyl;



-3-

a pyridinyl or naphthyl moiety optionally mono- or independently disubstituted with  $(C_{1-1})$ alkyl,  $(C_{1-1})$ alkoxy or halogen; cyclohexene; or adamantyl; and n is 1 to 3; or

 $R_2$  is phenoxy optionally mono- or independently disubstituted with  $(C_{14})$ alkyl, (C14)alkoxy or halogen; and

n is 2 or 3;

- d) (R<sub>3</sub>)<sub>2</sub>CH(CH<sub>2</sub>)<sub>2</sub>- wherein each R<sub>3</sub> independently is phenyl optionally mono- or independently disubstituted with (C14)alkyl, (C14)alkoxy or halogen;
- e)  $R_4(CH_2)_p$  wherein  $R_4$  is 2-oxopyrrolidinyl or  $(C_{2\cdot 4})$ alkoxy and p is 2 to 4;
- f) isopropyl optionally monosubstituted in 1-position with (C<sub>1-3</sub>)hydroxyalkyl;
- g) R<sub>5</sub> wherein R<sub>5</sub> is: indanyl; a pyrrolidinyl or piperidinyl moiety optionally substituted with benzyl; a [2.2.1]- or [3.1.1]bicyclic carbocyclic moiety optionally mono- or plurisubstituted with  $(C_{1-8})$  alkyl; adamantyl; or  $(C_{1-8})$  alkyl optionally mono- or independently plurisubstituted with hydroxy, hydroxymethyl or phenyl optionally monoor independently disubstituted with (C14)alkyl, (C14)alkoxy or halogen; in free form or in acid addition salt form.

The compounds of formula I can exist in free form or in acid addition salt form. Salt forms may be recovered from the free form in known manner and vice-versa. Acid addition salts may e.g. be those of pharmaceutically acceptable organic or inorganic acids. Although the preferred acid addition salts are the hydrochlorides, salts of methanesulfonic, sulfuric, phosphoric, citric, lactic and acetic acid may also be utilized.

The compounds of the invention may exist in the form of optically active isomers or diastereoisomers and can be separated and recovered by conventional techniques, such as chromatography.

"Alkyl" and "alkoxy" are either straight or branched chain, of which examples of the latter are isopropyl and tert-butyl.

R preferably is a), b) or e) as defined above. R<sub>1</sub> preferably is a pyridinyl or pyrimidinyl moiety optionally substituted as defined above. R<sub>18</sub> preferably is hydrogen. R<sub>2</sub> preferably is phenyl optionally substituted as defined above. R<sub>3</sub> preferably is unsubstituted phenyl.

Rrinteg108:04:2002

ODUC 19702486

PCT/EP97/06125 \_

WO 98/19998

-4-

R<sub>4</sub> preferably is alkoxy as defined above. R<sub>5</sub> preferably is optionally substituted alkyl as defined above. m preferably is 2. n preferably is 1 or 2, especially 2. p preferably is 2 or 3, especially 3.

Pyridinyl preferably is pyridin-2-yl; it preferably is unsubstituted or monosubstituted, preferably in 5-position. Pyrimidinyl preferably is pyrimidin-2-yl. It preferably is unsubstituted or monosubstituted, preferably in 4-position. Preferred as substitutents for pyridinyl and pyrimidinyl are halogen, cyano and nitro, especially chlorine.

When it is substituted, phenyl preferably is monosubstituted; it preferably is substituted with halogen, preferably chlorine, or methoxy. It preferably is substituted in 2-, 4- and/or 5-position, especially in 4-position.

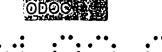
 $(C_{3\cdot12})$ cycloalkyl preferably is cyclopentyl or cyclohexyl. When it is substituted, it preferably is substituted with hydroxymethyl.  $(C_{1\cdot4})$ alkoxy preferably is of 1 or 2 carbon atoms, it especially is methoxy.  $(C_{2\cdot4})$ alkoxy preferably is of 3 carbon atoms, it especially is is isopropoxy. Halogen is fluorine, chlorine, bromine or iodine, preferably fluorine, chlorine or bromine, especially chlorine.  $(C_{1\cdot4})$ alkyl preferably is of 1 to 6, preferably 1 to 4 or 3 to 5, especially of 2 or 3 carbon atoms, or methyl.  $(C_{1\cdot4})$  alkyl preferably is methyl or ethyl, especially methyl.  $(C_{1\cdot3})$ hydroxyalkyl preferably is hydroxymethyl.

A [3.1.1]bicyclic carbocyclic moiety optionally substituted as defined above preferably is bicyclo[3.1.1]hept-2-yl optionally disubstituted in 6-position with methyl, or bicyclo[3.1.1]hept-3-yl optionally trisubstituted with one methyl in 2-position and two methyl groups in 6-position. A [2.2.1]bicyclic carbocyclic moiety optionally substituted as defined above preferably is bicyclo[2.2.1]hept-2-yl.

Naphthyl preferably is 1-naphthyl. Cyclohexene preferably is cyclohex-1-en-1-yl. Adamantyl preferably is 1- or 2-adamantyl.

A pyrrolidinyl or piperidinyl moiety optionally substituted as defined above preferably is pyrrolidin-3-yl or piperidin-4-yl. When it is substituted it preferably is N-substituted.







PCT/EP97/06125

WO 98/19998

-5-

A preferred group of compounds of the invention is the compounds of formula I wherein R is R' (compounds Ia), whereby R' is:

- R<sub>1</sub>'NH(CH<sub>2</sub>)<sub>2</sub>- wherein R<sub>1</sub>' is pyridinyl optionally mono- or independently disubstituted with halogen, trifluoromethyl, cyano or nitro; or unsubstituted pyrimidinyl;
- (C<sub>3.7</sub>)cycloalkyl optionally monosubstituted in 1-position with (C<sub>1-3</sub>)hydroxyalkyl;
- R<sub>4</sub>'(CH<sub>2</sub>)<sub>3</sub>- wherein R<sub>4</sub>' is (C<sub>2-4</sub>)alkoxy; or
- R<sub>5</sub>, wherein R<sub>5</sub> is as defined above;

in free form or in acid addition salt form.

More preferred compounds of the invention are those compounds of formula I wherein R is R" (compounds Ib), whereby R" is:

- $R_1$ "NH(CH<sub>2</sub>)<sub>2</sub>- wherein  $R_1$ " is pyridinyl mono- or independently disubstituted with halogen, trifluoromethyl, cyano or nitro;
- (C4.6)cycloalkyl monosubstituted in 1-position with (C1.3)hydroxyalkyl;
- R4'(CH2)3- wherein R4' is as defined above; or
- R<sub>5</sub>' wherein R<sub>5</sub>' is a [2.2.1]- or [3.1.1] bicyclic carbocyclic moiety optionally mono- or plurisubstituted with (C1-s)alkyl; or adamantyl;

in free form or in acid addition salt form.

Even more preferred compounds of the invention are the compounds of formula I wherein R is R"' (compounds Ic), whereby R" is:

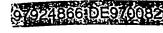
- R<sub>1</sub>"NH(CH<sub>2</sub>)<sub>2</sub>- wherein R<sub>1</sub>" is as defined above;
- (C46)cycloalkyl monosubstituted in 1-position with hydroxymethyl;
- R4'(CH2)3- wherein R4' is as defined above; or
- Rs" wherein Rs" is adamantyl;

in free form or in acid addition salt form.









PCT/EP97/06125

WO 98/19998

-6-

A further group of compounds of the invention is compounds Ip, wherein R is  $\mathbb{R}^p$ , which is:

- a) R<sub>1</sub><sup>p</sup>NH(CH<sub>2</sub>)<sub>2</sub>- wherein R<sub>1</sub><sup>p</sup> is a pyridinyl or pyrimidinyl moiety optionally mono- or independently disubstituted with halogen, trifluoromethyl, cyano or nitro;
- b) (C<sub>3-7</sub>)cycloalkyl optionally monosubstituted in 1-position with (C<sub>1-3</sub>)hydroxyalkyl;
- c)  $R_2^p(CH_2)_{2^-}$  wherein  $R_2^p$  is phenyl optionally mono- or independently di- or independently trisubstituted with halogen or  $(C_{1:3})$  alkoxy;
- d)  $(R_3^p)_2$ CH $(CH_2)_2$  wherein each  $R_3^p$  independently is phenyl optionally monosubstituted with halogen or  $(C_{1-3})$ alkoxy;
- e) R<sub>4</sub>(CH<sub>2</sub>)<sub>3</sub>- wherein R<sub>4</sub> is as defined above; or
- f) isopropyl optionally monosubstituted in 1-position with (C<sub>1-3</sub>)hydroxyalkyl; in free form or in pharmaceutically acceptable acid addition salt form.

A further group of compounds of the invention is compounds Is, wherein R is R<sup>e</sup>, which is:

a)  $R_1''R_{14}''(CH_2)_{ms}$ - wherein  $R_1''$  is pyridinyl optionally mono- or independently disubstituted with chlorine, trifluoromethyl, cyano or nitro; pyrimidinyl optionally monosubstituted with chlorine or trifluoromethyl; or phenyl;

R<sub>1a</sub> is hydrogen or methyl; and ms is 2 or 3;

- b) (C<sub>3-12</sub>)cycloalkyl optionally monosubstituted in 1-position with hydroxymethyl;
- c) R2 (CH2) as wherein either

R<sub>2</sub><sup>a</sup> is phenyl optionally mono- or independently di- or independently trisubstituted with halogen, alkoxy of 1 or 2 carbon atoms or phenylthio monosubstituted in the phenyl ring with hydroxymethyl; (C<sub>1-6</sub>)alkyl; 6,6-dimethylbicyclo[3.1.1]hept-2-yl; pyridinyl; naphthyl; cyclohexene; or adamantyl; and ns is 1 to 3; or

R<sub>2</sub> is phenoxy; and ns is 2;

d) (3,3-diphenyl)propyl;





-7-

- e)  $R_4$  (CH<sub>2</sub>)<sub>ps</sub> wherein  $R_4$  is 2-oxopyrrolidin-1-yl or isopropoxy and ps is 2 or 3;
- f) isopropyl optionally monosubstituted in 1-position with hydroxymethyl;
- g) R<sub>5</sub>\* wherein R<sub>5</sub>\* is: indanyl; a pyrrolidinyl or piperidinyl moiety optionally N-substituted with benzyl; bicyclo[2.2.1]hept-2-yl; 2,6,6-trimethylbicyclo[3.1.1]hept-3-yl; adamantyl; or (C<sub>1-8</sub>)alkyl optionally mono- or independently disubstituted with hydroxy, hydroxymethyl or phenyl; in free form or in acid addition salt form.

The compounds of the invention may be prepared by a process which comprises coupling a reactive (2-cyanopyrrolidino)carbonylmethylene compound with an appropriate substituted amine; more particularly, for the preparation of the compounds of formula I it comprises reacting a compound of formula II

wherein X is a reactive group, with a compound of formula III

NH<sub>2</sub>R

wherein R is as defined above,

and recovering the resultant compound of formula I in free form or in acid addition salt form.

Ш

X preferably is a halogen such as bromine, chlorine or iodine.

The process of the invention may be effected in conventional manner.

The compound of formula II is preferably reacted with at least 3 equivalents of a primary amine of formula III. The reaction is conveniently conducted in the presence of an inert, organic solvent, preferably a cyclic ether such as tetrahydrofuran. The temperature preferably is of from about 0° to about 35°C, preferably between about 0° and about 25°C.

The compounds of the invention may be isolated from the reaction mixture and purified in conventional manner, e.g. by chromatography.





-8-

The starting materials may also be prepared in conventional manner.

The compounds of formula II may e.g. be prepared by the following two-step reaction scheme:

Step 1 involves the reaction of the pyrrolidine of formula IV with a slight molar excess of a haloacetylhalide such as bromoacetylbromide or chloroacetylchloride and triethylamine and a catalytic amount of dimethylaminopyridine (DMAP). The reaction conveniently is conducted in the presence of an inert, organic solvent, preferably a chlorinated, aliphatic hydrocarbon such as methylene chloride, at a temperature of from about 0° to about 25°C, preferably at a temperature between about 0° and about 15°C.

Step 2 concerns the dehydration of the compound of formula V, prepared in Step 1, with at least 2 equivalents of trifluoroacetic anhydride (TFAA). The dehydration preferably is conducted in the presence of an inert, organic solvent such as tetrahydrofuran or a chlorinated, aliphatic hydrocarbon such as methylene chloride, at a temperature of from about 0° to about 25°C, preferably at a temperature between about 0° and about 15°C.

Insofar as its preparation is not particularly described herein, a compound used as starting material is known or may be prepared from known compounds in known manner or analogously to known methods or analogously to methods described in the Examples.

Chighty 40:





WO 98/19998

-9-

The following Examples illustrate the invention. All temperatures are in degrees Celsius.

# Example 1: 1-[2-[(5-Chloropyridin-2-yl)amino]ethylamino]acetyl-2-cyano-(S)-pyrrolidine

To a 500 ml flask is added 16.6 g of 2-[(5-chloropyridin-2-yl)amino]ethylamine and 100 ml of tetrahydrofuran and the mixture is cooled in an ice bath. To the cooled mixture is added 7.0 g of (2-cyanopyrrolidino)carbonylmethylene-(S)-bromide dissolved in 30 ml of tetrahydrofuran. The resultant mixture is stirred for 2 hours at 0°, the solvent is removed by rotovaping and the mixture is partitioned between ethyl acetate and water. The product is then extracted into the ethyl acetate layer and the aqueous layer is then washed twice with ethyl acetate. The combined organic layers are washed successively with water and brine, dried over sodium sulfate and concentrated to obtain the desired free base compound in crude form. The crude form is then purified on silica gel employing a mixture of 5% methanol in methylene chloride as the eluent to yield the title compound in free base form as a light brown oil.

After dissolving the free base in 30 ml of dry tetrahydrofuran, hydrogen chloride gas is bubbled into the solution for five seconds. The off-white precipitate that forms is filtered, washed with dry tetrahydrofuran and the solvent is removed by high vacuum pumping to obtain the title compound in dihydrochloride acid addition salt form (off-white solid; m.p. 265°-267°; NMR: see \* at bottom of Table hereunder).

The starting material is obtained as follows:

a) 22.37 g of (S)-2-carbamoylpyrrolidine, 30.1 ml of triethylamine and 30.0 mg of dimethylaminopyridine (DMAP) are dissolved in 200 ml of methylene chloride and the solution is then added, dropwise, to an ice-cold solution of 18.8 ml of bromoacetylbromide in 192 ml of methylene chloride, over a period of 60 minutes under a calcium sulfate drying tube. The resultant solution is stirred for 2 hours at ice-water temperature under a calcium sulfate drying tube, then poured into 3.5 liters of ethyl acetate. The resultant precipitate is filtered, washed with ethyl acetate, and the filtrate is concentrated to obtain (2-carbamoylpyrrolidino)-carbonylmethylene-(S)-bromide (hard yellow taffy).

T.





-10-

b) 50.0 g of the bromide compound prepared in a) above is dissolved in 300 ml of methylene chloride and the solution is cooled in an ice water bath under a calcium sulfate drying tube. The cooled solution is then poured into 60.2 ml of trifluoroacetic anhydride over a 2 minute period, the resultant solution is stirred at ice-water temperature under a calcium sulfate drying tube for 4 hours, and partitioned between methylene chloride and saturated aqueous sodium bicarbonate. The product is extracted into the methylene chloride layer and the aqueous layer is washed twice with methylene chloride. The combined organic layers are washed successively with water and brine and then dried over sodium sulfate. The solution is filtered and the solvent is removed by rotovaping and high vacuum pumping to obtain (2-cyanopyrrolidino)carbonylmethylene-(S)-bromide (dark yellow solid).

The following compounds of the invention, of formula I, are obtained in analogous manner by reacting a corresponding compound of formula II with a corresponding compound of formula III (in the following Table, where only an acid addition salt form of a compound of the invention is mentioned, the compound is recovered from the free base without isolation thereof):

Example No.	<b>M</b>	Form	Analogously to Ex. No.	Analogously Characterization data to Ex. No.	i
,	2-[(\$.CRnyridin-2-v )aminolethyl	م	· ID	golden oil; NMR*	
<b>1</b> 11	2.[(S.cvanoperidin-2.v)]aminolethyl	م	_	golden oil	
,		qcp		off-white precipitate, m.p. 155-157°; NMR*;	
			•	$[\alpha]_D^{20} = -77.2^{\circ} (c=0.012, MeOH)$	
4	2-[(pvrimidin-2-v])amino]ethy]	م	214)	golden oil; NMR*	
· w	(1-hydroxymethyl)cyclopent-1-yl	Ą	1 <sup>2)</sup>	yellow solid; m.p. 65-67°; NMR*	
· <b>v</b> o		م	23)	golden oil; NMR*	
, <del>4</del>	2-[(4-chloropyrimidin-2-vl)amino]ethyl	م	2	tan solid; NMR*	
£	2-[(3-chloropyridin-2-yl)aminolethyl	م	7	golden oil; NMR*	
27	2-[(4-CFpyrimidin-2-yl)amino]ethyl	Ą		golden oil; NMR*	
5	2-(2-chlorophenyl)ethyl	م	7	NMR*	
Œ	(3.3-diphenyl)propyl	م	2	NMR*	
•	2-[(5-nitropyridin-2-vl)aminolethyl	þ	534)	bright yellow thick oil; NMR*	
<b>6</b>	2-[(3-chloro-5-CF,-pyridin-2-vl)amino]ethyl	م.	2 <sup>3b)</sup>	golden oil; NMR*	
98	2-[(3-CF-pyridin-2-yl)aminolethyl	م	2 <sup>3b)</sup>	golden oil; NMR*	
ည်	2-[(3.5-dichloropyridin-2-yl)aminolethyl	٩	2 <sup>3b)</sup>	golden oil; NMR*	
9	cyclopent-1-vl	Ą	7	tan solid	
ì		둉	-	white solid; NMR*	
11	2-(2-bromo-4,5-dimethoxyphenyl)ethyl	٩	534)	clear light yellow, thick oil; NMR*	
12	3-(kopropoxy)propyl	م	-	brown oil	
ļ		ch	<b>9</b>	white solid, m.p. 174-176°; NMR*	
				-	





	֡			۶
<b>~</b>	Form	Analogously Chara to Ex. No.		V19998
ro Ct (4 bud-commethel)menny	to to	1 <sup>11)</sup> off-w	nite solid: m.p. 80-82°; <sup>13</sup> C-NMR: 118.2 (ppm)	
[5,5]-(L-ii)di Ox) incuij ijpi opji	; -£	1 <sup>12)</sup> vellov	solid: m.n. 65-67": <sup>13</sup> C-NMR: 121.4 (ppm)	
[2-[(2-bydroxymemyi)phenyi]unojphenyuneniyi 2/2 mothozmbanullathul	5 •5	1 off-w	nite solid; m.p. 174-176°; <sup>13</sup> C-NMR: 121.7 (ppm)	
C-(K-memox) pressy sycasty C-badrovemental	당	1 sticky	light-green solid; 13C-NMR: 121.67 (ppm)	
o-more periods from the confidence of the confid	ch	1 off-white sc	lid; m.p. 274-278° (dec.); "C-NMR: 121.64 (ppm)	
2-(2-4-dichlorophenyl)ethyl	ch		fluffy solid;m.p.154-156°; "C-NMR: 121.48 (ppm)	
1-(S)-(+)-hydroxymethyl-3-methylbutyl	당		/ellow solid; m.p. 65-66°; ''C-NMR: 117.99 (ppm)	
[1R*.2S*1.2-hydroxy-2-phenylethyl	윤		rellow solid; m.p. 82-83°; "C-NMR: 118.35 (ppm)	
2-(2-fluorophenyl)ethyl	с <del>р</del>	1 white	fluffy solid;m.p.160-162; "C-NMR: 121.70 (ppm)	
cyclopropyl	ch	1 off-w	hite solid; m.p. 170-172°; "C-NMR: 121.62 (ppm)	
[1SI1S.2S.3S.5R]]-2,6,6-trimethylbicyclo-				
[3.1.1]hept-3-yl	유		solid; m.p. 84-86°; "C-NMR: 121.8 (ppm)	
(2-phenoxy)ethyl	ch Ch	1 sticky	golden solid; "C-NMR: 121.7 (ppm)	
2-(3.5-dimethoxyphenyl)ethyl	c <del>,</del>	1 white	fluffy solid; m.p. 74-76°; "C-NMR: 121.66 (ppm)	
1-adamantyl	윤	1 white	solid; m.p. 240-242°; "C-NMR: 121.80 (ppm)	
1,1,3,3-tetramethylbutyl	당	I white	fluffy solid; m.p. 68-70"; "C-NMR: 121.55 (ppm)	
2-adamantyi	당	1 off-w	hite solid; m.p. 122-124%; "C-NMR: 121.69 (ppm)	
1.1-dimethylpropyl	당	1 white	fluffy solid; m.p. 62-64"; "C-NMR: 121.53 (ppm)	,
benzyl	ch	. 1 white	solid; m.p. 58-60°; <sup>13</sup> C-NMR: 121.38 (ppm)	CI
1,1-dimethylethyl	다	1 white	solid; m.p. 226-228°; "C-NMR: 121.56 (ppm)	, r. c
(2-adamantyl)methyl	단	l white	solid; m.p. 158-160°; "C-NMR: 121.53 (ppm)	711
2-phenylethyl	당	1 white solid	; m.p. 275-280° (dec.); ''C-NMR: 121.52 (ppm)	
pentyl	당	1 white	solid; m.p. 176-178°; "C-NMR: 121.67 (ppm)	
butyl	ch	. 1 white	solid; m.p. 180-182°; <sup>13</sup> C-NMR: 121.53 (ppm)	-
	I-hydroxymethyl)proceptoxymethyl)proceptoxymethyl)phenethoryphenyl)ethyl dichlorophenyl)ethyl dichlorophenyl)ethyl dichlorophenyl)ethyl ropyl (3.1.1]hept-3-yl enoxy)ethyl enoxy)ethyl mantyl mantyl mantyl methylpropyl methylpropyl methylpropyl methylpropyl methylpropyl methylpropyl methylpropyl methylpropyl nylethyl	droxymethyl)propyl oxymethyl)phenyllthio]phenylmethyl xyphenyl)ethyl lorophenyl)ethyl ydroxymethyl-3-methylbutyl 2-hydroxy-2-phenylethyl hphenyl)ethyl il 3S,5R]]-2,6,6-trimethylbicyclo- 1.1]hept-3-yl y)ethyl ethoxyphenyl)ethyl tyl inylpropyl nylethyl nylethyl tyl tyl tyl tyl tyl tyl tyl tyl tyl t	droxymethyl)propyl  characterial characteria	droxymethyl)propyl  ch 1110 off-white solid; m.p. 80-82°, ¹¹C-NMR: 118.2 (ppm)  cymedinyl)phenyllthio phenylmethyl ch 1120 yellow solid; m.p. 174-176°, ¹¹C-NMR: 121.4 (ppm)  ch 1 sticky light-green solid; m.p. 174-176°, ¹¹C-NMR: 121.6 (ppm)  ch 1 off-white solid; m.p. 174-176°, ¹¹C-NMR: 121.6 (ppm)  ch 1 off-white solid; m.p. 174-176°, ¹¹C-NMR: 121.64 (ppm)  ch 1 off-white solid; m.p. 174-176°, ¹¹C-NMR: 121.64 (ppm)  ch 1 off-white solid; m.p. 174-176°, ¹¹C-NMR: 121.64 (ppm)  ch 1 off-white solid; m.p. 174-176°, ¹¹C-NMR: 121.64 (ppm)  ch 1 off-white solid; m.p. 174-176°, ¹¹C-NMR: 121.64 (ppm)  ch 1 white fulffy solid; m.p. 174-176°, ¹¹C-NMR: 121.8 (ppm)  ch 1 white solid; m.p. 174-176°, ¹¹C-NMR: 121.66 (ppm)  ch 1 white solid; m.p. 240-242°, ¹¹C-NMR: 121.56 (ppm)  ch 1 white solid; m.p. 240-242°, ¹¹C-NMR: 121.56 (ppm)  ch 1 white solid; m.p. 122-124°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 226-228°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 226-228°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 122-124°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 122-124°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 122-228°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 122-28°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 122-128°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 125-28°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 125-28°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 125-28°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 125-28°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 126-128°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 127-128°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 127-128°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 127-128°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 127-128°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 127-128°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 127-128°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 127-128°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 127-128°, ¹¹C-NMR: 121.53 (ppm)  ch 1 white solid; m.p. 127-128°, ¹¹C-NMR: 12

ODOO
------

....

924866 DE97008

PCT/EP97/06125

WO 98/19998

	- 14 -	
Analogously Characterization data to Ex. No.	white fluffy solid; <sup>13</sup> C-NMR: 121.52 (ppm) white fluffy solid; <sup>13</sup> C-NMR: 121.64 (ppm) white solid; m.p. 193-194°; <sup>13</sup> C-NMR: 121.57 (ppm) off-white sticky solid; <sup>13</sup> C-NMR: 121.67 (ppm) white solid; m.p. 170-172°; <sup>13</sup> C-NMR: 121.7 (ppm) white sticky solid; m.p. 210-212°; <sup>13</sup> C-NMR: 119.33 (ppm) white fluffy sticky solid; <sup>13</sup> C-NMR: 119.35 (ppm) white solid; m.p. 280-283° (dec.); <sup>13</sup> C-NMR: 121.38 (ppm)	dch = in dihydrochloride form
Analogously to Ex. No.	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	dch = in dihyd
Fоrm	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	
ಜ	inyl)aminolpropyl en-2-yl	ch= in monohydrochloride form; m.p.= melting point
	cyclododecyl cyclooctyl propyl ethyl heptyl hexyl 3-[(5-cyano-2-pyridinyl)amino]propyl 1-ethylpropyl 2,3-dibydro-1H-inden-2-yl 1-benzylpiperidin-4-yl	b = in free base form dec.= decomposes;
Example No.	22 82 83 82 83 83 83 83 83 83 83 83 83 83 83 83 83	

" starting from 2-[(5-trifluoromethylpyridin-2-yl)amino]ethylamine in tetrahydrofuran, using 5 % methanol in methylene chloride as eluent using 10 % methanol in methylene chloride as eluent

" reacting (1-hydroxymethyl)cyclopentylamine in anhydrous tetrahydrofuran for 18 h at room temperature under a calcium sulfate drying tube "using methylene chloride, methanol and ammonium hydroxide 90:10:0.5 as eluent

<sup>10)</sup>using flash chromatography, employing a mixture of 5 % methanol in methylene chloride as eluent

4) using methylene chloride, methanol and ammonium hydroxide 80:20:1 as eluent 30, using 3 % methanol in methylene chloride as eluent

9) using methylene chloride, methanol and ammonium hydroxide 90:10:1 as eluent

o reacting (1-aminocyclohexane) methanol in tetrahydrofuran with 1-chloroacetyl-2-(S)-cyanopyrrolidine (prepared from chloroacetylchloride and L-prolinamide and reaction of the resultant product with trifluoroacetic anhydride) at ice-temperature under a calcium sulfate drying tube, and purifying the reaction mixture on silicagel employing 5 % methanol in methylene chloride as eluent File(16:40:40:42002)

ODOC

.....

979

PCT/EP97/06125

को १८३ वर्ध कि हिंदि भी भी भी प्राप्त

WO 98/19998

- 15.-

nusing (3R)-(-)-1-benzyl-3-aminopyrrolidine as starting material

8) using (-)-cis-myrtanylamine as starting material 9) using (+/-)-exo-2-aminonorbornane as starting material

using (+/-)-exc\_rammonon bon mane as seaming material on using (1R,2R,3R,5S)-(-)-isopinocampheylamine as starting material

using (S)-(+)-2-amino-1-butanol as starting material

12) using 2-(2-aminomethyl)phenylthio)benzyl alcohol as starting material

13) using (S)-(+)-leucinol as starting material

14) using (1R,2S)-(-)-norephedrine as starting material

13) using (1S,2S,3S,5R)-(+)-Isopinocampheylamine as starting material

16) using 2-(3-aminopropylamino)-5-cyanopyridine as starting material

## • NMR:

Compound #	<sup>13</sup> C-NMR (MHz, solvent) d ppm (CN)	m (CN)
Ex. 5	<sup>13</sup> C NMR (75 MHz, CD <sub>3</sub> OD)	d 119.64 ppm (CN)
Ex. 12	<sup>13</sup> C NMR (75 MHz, D <sub>2</sub> O)	d 121.63 ppm (CN)
Ex. 1	<sup>13</sup> C NMR (75 MHz, D <sub>2</sub> O)	d 121.60 ppm (CN)
Ex. 3	<sup>13</sup> C NMR (75 MHz, D <sub>2</sub> 0)	d 120.42 ppm (CN)
Ex. 8	<sup>13</sup> C NMR (75 MHz, DMSO)	d 119.13 ppm (CN)
Ex. 7B	<sup>13</sup> C NMR (75 MHz, CDC1 <sub>3</sub> )	d 118.23 ppm (CN)
Ex. 9A	<sup>13</sup> C NMR (75 MHz, CD <sub>3</sub> OD)	d 119.68 ppm (CN)
Ex. 9B	<sup>13</sup> C NMR (75 MHz, CD,OD)	d 119.66 ppm (CN)

Rifiledi08:04-2002

WO 98/19998

ODOC 4

070378999 BE81/0082

- 16 -

PCT/EP97/06125

# punoumo.	13C NMR (MHz, solvent) d ppm (CN)	(CN)
John Poure ::	13C NMR (75 MHz, CD,OD)	d 119.68 ppm (CN)
יא. אר	Desire (75 MHz (T).OD)	d 119.84 ppm (CN)
Ex. 6	C NIME (13 IMILE, CO.)	(NL) 10 000
Ex. 7C	13C NMR (75 MHz, CDCl3)	d 118.23 ppm (Cav)
Ex. 2	13C NMR (75 MHz, CD,OD)	d 119.68 ppm (CN)
Ex. 7A	<sup>13</sup> C NMR (75 MHz, CD,OD)	d 119.66 ppm (CN)
Ev 4	13C NIMR (75 MHz, CD,OD)	d 119.66 ppm (CN)
	<sup>13</sup> C NMR (75 MHz, D <sub>2</sub> 0)	d 121.69 ppm (CN)
EX. 10	13C NAMP (75 MHz, CDC11)	d 118.31 ppm (CN)
Ex. 11	CINE CONTRACTOR	4 119 63 nom (CN)
Ex. 7D	COMR (75 MHZ, CD,OD)	(NO) THE POOL OF
Ex. 7E	"C NMR (75 MHz, CD,OD)	d 119.04 ppm (LL)
Ex. 13	13C NMR (75 MHz, D20)	d 121.52 ppm (CN)
Ex. 14	<sup>13</sup> C NMR (75 MHz, D <sub>2</sub> 0)	d 121.52 ppm (CN)

Printect08:04:2002

WO 98/19998

PCT/EP97/06125 \_

-17-

The compounds of the invention in free form or in pharmaceutically acceptable acid addition salt form, hereinafter briefly named "the agents of the invention", in particular, the compounds of formula I in free form or in pharmaceutically acceptable acid addition salt form, possess pharmacological activity. They are therefore indicated for use as pharmaceuticals.

In particular, they inhibit DPP-IV. This activity may be demonstrated employing the Caco-2 DPP-IV assay, which measures the ability of test compounds to inhibit DPP-IV activity from human colonic carcinoma cell extracts. The human colonic carcinoma cell line Caco-2 can be obtained from the American Type Culture Collection (ATCC HTB 37). Differentiation of the cells to induce DPP-IV expression is accomplished as described by Reisher et al. in Proc.Natl.Acad.Sci.USA 90 (1993) 5757-5761. Cell extract is prepared from cells solubilized in 10 mM Tris-HC1, 0.15 M NaC1, 0.04 t.i.u. (trypsin inhibitor unit) aprotinin, 0.5% non-ionic detergent P40, pH 8.0, which is centrifuged at 35 000 g for 30 min at 4°C to remove cell debris. The assay is conducted by adding 20 mg solubilized Caco-2 protein, diluted to a final volume of 125 ml in assay buffer (25 mM Tris-HC1 pH 7.4, 140 mM NaCl, 10 mM KCl, 1% bovine serum albumin) to microtiter plate wells. The reaction is initiated by adding 25ml of 1 mM substrate (H-Alanine-Proline-pNA; pNA is p-nitroaniline). The reaction is run at room temperature for 10 minutes after which time a 19 ml volume of 25% glacial acetic acid is added to stop the reaction. Test compounds are typically added as 30 ml additions and the assay buffer volume is reduced to 95 ml. A standard curve of free p-nitroaniline is generated using 0-500 mM solutions of free pNA in assay buffer. The curve generated is linear and is used for interpolation of substrate consumption (catalytic activity in nmoles substrate cleaved /min). The endpoint is determined by measuring absorbance at 405 nm in a Molecular Devices UV Max microtiter plate reader. The potency of the test compounds as DPP-IV inhibitors, expressed as IC50, is calculated from 8-point, dose-response curves using a 4-parameter logistic function.

In the above test, IC<sub>50</sub> values of from about 10 nM to about 900 nM are obtained with the agents of the invention, e.g. 22 nM for the agent of Example 3.

The DPP-IV inhibition may also be demonstrated by measuring the effects of test compounds on DPP-IV activity in human and rat plasma employing a modified version of the assay described by Kubota et al. in <u>Clin.Exp.Immunol.</u> 89 (1992) 192-197. Briefly, five ml of plasma are added to 96-well flat-bottom microtiter plates (Falcon), followed by the addition





-18-

of 5 ml of 80 mM MgCl<sub>2</sub> in incubation buffer (25 mM HEPES, 140 mM NaCl, 1 % RIA-grade BSA, pH 7.8). After a 5 min incubation at room temperature, the reaction is initiated by the addition of 10 ml of incubation buffer containing 0.1 mM substrate (H-Glycine-initiated by the addition of 10 ml of incubation buffer containing 0.1 mM substrate (H-Glycine-Proline-AMC; AMC is 7-amino-4-methylcoumarin). The plates are covered with aluminum foil (or kept in the dark) and incubated at room temperature for 20 min. After the 20 min reaction, fluorescence is measured using a CytoFluor 2350 fluorimeter (Excitation 380 nm Emission 460 nm; sensitivity setting 4). Test compounds are typically added as 2 ml additions and the assay buffer volume is reduced to 13 ml. A fluorescence-concentration curve of free AMC is generated using 0-50 mM solutions of AMC in assay buffer. The curve generated is linear and is used for interpolation of substrate consumption (catalytic activity in nmoles substrate cleaved/min). As with the previous assay, the potency of the test compounds as DPP-IV inhibitors, expressed as IC<sub>50</sub>, is calculated from 8-point, dose-response curves using a 4 parameter logistic function.

In the above assay, IC<sub>50</sub> values of from about 7 nM to about 2000 nM are obtained in human plasma, and of from about 3 nM to about 400 nM in rat plasma, e.g., for the agent of Example 3, of 7 nM in human and 6 nM in rat plasma, respectively.

In view of their ability to inhibit DPP-IV, the agents of the invention are indicated for use in treating conditions mediated by DPP-IV. It is expected that the compounds disclosed herein are useful in the treatment of non-insulin-dependent diabetes mellitus, arthritis, obesity, and osteoporosis such as calcitonin-osteoporosis. The agents of the invention improve early insulin response to an oral glucose challenge and, therefore, are invention indicated for use in treating non-insulin-dependent diabetes mellitus and particularly indicated for use in treating non-insulin-dependent diabetes mellitus and further conditions of impaired glucose tolerance (IGT).

The ability of the agents of the invention to improve early insulin response to an oral glucose challenge may e.g. be measured in insulin resistant rats according to the following method:

method:

Male Sprague-Dawley rats that have been fed a high fat diet (saturated fat = 57 % calories) for 2-3 weeks are fasted for approximately 2 hours on the day of testing, divided into groups of 8-10, and dosed orally with 10 mmol/kg of the test compounds in carboxymethylcellulose (CMC). An oral glucose bolus of 1 g/kg is administered 30 min after











-19-

the test compound directly into the stomach of the test animals. Blood samples, obtained at various timepoints from chronic jugular vein catheters are analyzed for plasma glucose and immunoreactive insulin (IRI) concentrations, and plasma DPP-IV activity. Plasma insulin levels are assayed by a double antibody radioimmunoassay (RIA) method using a specific anti-rat insulin antibody from Linco Research (St. Louis, MO, USA). The RIA has a lower limit of detection of 0.5 mU/ml with intra- and inter-assay variations of less than 5%. Data are expressed as % increase of the mean of the control animals.

It was found that upon oral administration, each of the compounds tested amplified the early insulin response which led to an improvement in glucose tolerance in the insulin resistant test animals. The following results were obtained:

Compound	Increase of insulin response at 10 mmol/kg
Ex. 1	61 %
Ex. 3	66 %
Ex. 5	108 %
Ex. 8	144 %
Ex. 12	59 %

The precise dosage of the agents of the invention to be employed for treating conditions mediated by DPP-IV inhibition depends upon several factors, including the host, the nature and the severity of the condition being treated, the mode of administration and the particular compound employed. However, in general, conditions mediated by DPP-IV inhibition are effectively treated when an agent of the invention is administered enterally, e.g. orally, or parenterally, e.g. intravenously, preferably orally, at a daily dosage of from about 0.002 mg/kg to about 5 mg/kg, preferably of from about 0.02 mg/kg to about 2.5 mg/kg body weight or, for most larger primates, a daily dosage of from about 0.1 mg to about 250 mg, preferably from about 1 mg to about 100 mg. A typical oral dosage unit is from about 0.01 mg/kg to about 0.75 mg/kg, one to three times a day. Usually, a small dose is administered initially and the dosage is gradually increased until the optimal dosage for the host



979F486 979F486 PCT/EP97/06125

under treatment is determined. The upper limit of dosage is that imposed by side effects and can be determined by trial for the host being treated.

-20-

The agents of the invention may be combined with one or more pharmaceutically acceptable carriers and, optionally, one or more other conventional pharmaceutical adjuvants and administered enterally, e.g. orally, in the form of tablets, capsules, caplets, etc., or parenterally, e.g. intravenously, in the form of sterile injectable solutions or suspensions. The enteral and parenteral compositions may be prepared by conventional means.

The agents of the invention may be formulated into enteral and parenteral pharmaceutical compositions containing an amount of the active substance that is effective for treating conditions mediated by DPP-IV, such compositions in unit dosage form and such compositions comprising a pharmaceutically acceptable carrier.

Those agents of the invention which are e.g. of formula I may be administered in enantiomerically pure (S) form (e.g.  $\geq 98$  %, preferably  $\geq 99$  % pure) or together with the other enantiomer, e.g. in racemic form. The above dosage ranges are based on the compounds of formula I (excluding the amount of R enantiomer).

The invention thus also comprises an agent of the invention, in particular, a compound of formula I as defined above, in free form or in pharmaceutically acceptable acid addition salt form, for use as a pharmaceutical. It further includes a pharmaceutical composition comprising an agent of the invention, in particular a compound of formula I as defined above, in free form or in pharmaceutically acceptable acid addition salt form, together with at least one pharmaceutically acceptable carrier or diluent. It further comprises the use of an agent of the invention, in particular, a compound of formula I as defined above, in free form or in pharmaceutically acceptable acid addition salt form in the preparation of a medicament for inhibiting DPP-IV or treating conditions mediated by DPP-IV, by a process comprising mixing an agent of the invention with a pharmaceutically acceptable carrier or diluent. It further provides a method of inhibiting DPP-IV, or of treating conditions mediated by DPP-IV, which comprises administering to a patient in need of such treatment a therapeutically effective amount of a compound of the invention, in particular, of formula I in free form or in pharmaceutically acceptable acid addition salt form.

200242042002

WO 98/19998

PCT/EP97/06125 \_

-21-

The agents of Examples 1, 3, 5, 8 and 12 are the preferred agents of the invention, particularly those of Examples 1, 3, 5 and 12, preferably in hydrochloride acid addition salt form, especially the agent of Example 3, namely 1-[2-[(5-cyanopyridin-2-yl)amino]-ethylamino]acetyl-2-cyano-(S)-pyrrolidine, preferably in dihydrochloride acid addition salt form. It has been determined that in hydrochloride form they have an IC<sub>50</sub> value in the Caco-2 DPP-IV assay of, respectively, 36, 22, 26, 8 and 279 nM, and in the modified Kubota assay above, an IC<sub>50</sub> value for, respectively, human and rat plasma DPP-IV, of 27 and 22 nM (Example 1); 7 and 6 nM (Example 3); 37 and 18 nM (Example 5); 12 and 11 nM (Example 8); and 95 and 38 nM (Example 12). It is, therefore, indicated that for the above uses the compounds of Examples 1, 3, 5, 8 and 12 may be administered to larger mammals, for example humans, by similar modes of administration at similar dosages than conventionally employed with metformin.







-22-

PCT/EP97/06125 \_

Claims:

WO 98/19998

- 1. An N-(N'-substituted glycyl)-2-cyanopyrrolidine.
- 2. A compound of formula I:

wherein R is:

a) R<sub>1</sub>R<sub>1•</sub>N(CH<sub>2</sub>)<sub>m</sub>- wherein

R<sub>1</sub> is a pyridinyl or pyrimidinyl moiety optionally mono- or independently disubstituted with (C<sub>1-4</sub>)alkyl, (C<sub>1-4</sub>)alkoxy, halogen, trifluoromethyl, cyano or nitro; or phenyl optionally mono- or independently disubstituted with (C<sub>1-4</sub>)alkyl, (C<sub>1-4</sub>)alkoxy or halogen;

 $R_{1a}$  is hydrogen or  $(C_{1.a})$ alkyl; and m is 2 or 3;

- b) (C3-12)cycloalkyl optionally monosubstituted in the 1-position with (C1-3)hydroxyalkyl;
- c) R<sub>2</sub>(CH<sub>2</sub>)<sub>n</sub>- wherein either

 $R_2$  is phenyl optionally mono- or independently di- or independently trisubstituted with  $(C_{1:4})$ alkyl,  $(C_{1:4})$ alkoxy, halogen or phenylthio optionally monosubstituted in the phenyl ring with hydroxymethyl; or is  $(C_{1:4})$ alkyl; a [3.1.1]bicyclic carbocyclic moiety optionally mono- or plurisubstituted with  $(C_{1:4})$ alkyl; a pyridinyl or naphthyl moiety optionally mono- or independently disubstituted with  $(C_{1:4})$ alkyl,  $(C_{1:4})$ alkoxy or halogen; cyclohexene; or adamantyl; and

n is 1 to 3; or

 $R_3$  is phenoxy optionally mono- or independently disubstituted with  $(C_{1-1})$ alkyl,  $(C_{1-1})$ alkoxy or halogen; and

n is 2 or 3;

d) (R<sub>3</sub>)<sub>2</sub>CH(CH<sub>2</sub>)<sub>2</sub>- wherein each R<sub>3</sub> independently is phenyl optionally mono- or independently disubstituted with (C<sub>1-4</sub>)alkyl, (C<sub>1-4</sub>)alkoxy or halogen;







-23-

PCT/EP97/06125\_

- e) R<sub>4</sub>(CH<sub>2</sub>)<sub>p</sub>- wherein R<sub>4</sub> is 2-oxopyrrolidinyl or (C<sub>2-4</sub>)alkoxy and p is 2 to 4;
- f) isopropyl optionally monosubstituted in 1-position with (C<sub>1.3</sub>)hydroxyalkyl;
- g) R<sub>5</sub> wherein R<sub>5</sub> is: indanyl; a pyrrolidinyl or piperidinyl moiety optionally substituted with benzyl; a [2.2.1]- or [3.1.1]bicyclic carbocyclic moiety optionally mono- or plurisubstituted with (C<sub>1-8</sub>)alkyl; adamantyl; or (C<sub>1-8</sub>)alkyl optionally mono- or independently plurisubstituted with hydroxy, hydroxymethyl or phenyl optionally mono- or independently disubstituted with (C<sub>1-4</sub>)alkyl, (C<sub>1-4</sub>)alkoxy or halogen;

in free form or in acid addition salt form,

- 3. A compound according to claim 2 (a compound Ip) wherein R is R<sup>p</sup>, which is:
- a) R<sub>1</sub><sup>p</sup>NH(CH<sub>2</sub>)<sub>2</sub>- wherein R<sub>1</sub><sup>p</sup> is a pyridinyl or pyrimidinyl moiety optionally mono- or independently disubstituted with halogen, trifluoromethyl, cyano or nitro;
- b) (C<sub>3-7</sub>)cycloalkyl optionally monosubstituted in 1-position with (C<sub>1-3</sub>)hydroxyalkyl;
- c)  $R_2^p(CH_2)_{2^-}$  wherein  $R_2^p$  is phenyl optionally mono- or independently di- or independently trisubstituted with halogen or  $(C_{1.3})$  alkoxy;
- d)  $(R_3^p)_2CH(CH_2)_2$  wherein each  $R_3^p$  independently is phenyl optionally monosubstituted with halogen or  $(C_{1.5})$ alkoxy;
- e) R<sub>4</sub>(CH<sub>2</sub>)<sub>3</sub>- wherein R<sub>4</sub> is as defined above; or
- f) isopropyl optionally monosubstituted in 1-position with (C<sub>1-3</sub>)hydroxyalkyl; in free form or in acid addition salt form.
- 4. A compound according to claim 2 (a compound Is), wherein R is R<sup>s</sup>, which is:
- a) R<sub>1</sub>\*R<sub>1\*</sub>\*(CH<sub>2</sub>)<sub>ms</sub>- wherein R<sub>1</sub>\* is pyridinyl optionally mono- or independently disubstituted with chlorine, trifluoromethyl, cyano or nitro; pyrimidinyl optionally monosubstituted with chlorine or trifluoromethyl; or phenyl;

 $R_{1a}$  is hydrogen or methyl; and ms is 2 or 3;

b) (C3-12)cycloalkyl optionally monosubstituted in 1-position with hydroxymethyl;





РСТ/ЕР97/06125 \_

-24-

c) R<sub>2</sub>\*(CH<sub>2</sub>)<sub>m</sub>- wherein either

WO 98/19998

R<sub>2</sub>" is phenyl optionally mono- or independently di- or independently trisubstituted with halogen, alkoxy of 1 or 2 carbon atoms or phenylthio monosubstituted in the phenyl ring with hydroxymethyl; (C<sub>1-6</sub>)alkyl; 6,6-dimethylbicyclo[3.1.1]hept-2-yl; pyridinyl; naphthyl; cyclohexene; or adamantyl; and ns is 1 to 3; or R<sub>2</sub>" is phenoxy; and ns is 2;

- d) (3,3-diphenyl)propyl;
- e) R<sub>4</sub>\*(CH<sub>2</sub>)<sub>ps</sub> wherein R<sub>4</sub>\* is 2-oxopyrrolidin-1-yl or isopropoxy and ps is 2 or 3;
- f) isopropyl optionally monosubstituted in 1-position with hydroxymethyl;
- g) R<sub>5</sub>\* wherein R<sub>5</sub>\* is: indanyl; a pyrrolidinyl or piperidinyl moiety optionally N-substituted with benzyl; bicyclo[2.2.1]hept-2-yl; 2,6,6-trimethylbicyclo[3.1.1]hept-3-yl; adamantyl; or (C<sub>1.8</sub>)alkyl optionally mono- or independently disubstituted with hydroxy, hydroxymethyl or phenyl;

in free form or in acid addition salt form.

- 5. The compound according to claim 2 wherein R is 2-[(5-cyanopyridin-2-yl)amino]ethyl, i.e. 1-[2-[(5-cyanopyridin-2-yl)amino]ethylamino]acetyl-2-cyano-(S)-pyrrolidine, in free form or in acid addition salt form, especially in dihydrochloride acid addition salt form, or a compound according to claim 2 which is of formula I wherein R is either
- 2-[(5-chloropyridin-2-yl)amino]ethyl, or
- (1-hydroxymethyl)cyclopent-1-yl, or
- 2-[(5-nitropyridin-2-yl)amino]ethyl, or
- 3-(isopropoxy)propyl,

in free form or in acid addition salt form.

6. A process for the preparation of a compound according to claim 1 which comprises coupling a reactive (2-cyanopyrrolidino)carbonylmethylene compound with an appropriate substituted amine or, for the preparation of a compound according to claim 2, which comprises





-25-

reacting a compound of formula II

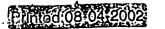
wherein X is a reactive group, with a compound of formula III

NH<sub>2</sub>R

Ш

wherein R is as defined in claim 2, and recovering the resultant compound in free form or in acid addition salt form.

- 7. A pharmaceutical composition comprising a compound according to claim 1 in free form or in pharmaceutically acceptable acid addition salt form, together with at least one pharmaceutically acceptable carrier or diluent.
- 8. A compound according to claim 1 in free form or in pharmaceutically acceptable acid addition salt form, for use as a pharmaceutical.
- 9. Use of a compound according to claim I in free form or in pharmaceutically acceptable acid addition salt form in the preparation of a medicament for inhibiting DPP-IV or treating conditions mediated by DPP-IV.
- 10. A method of inhibiting DPP-IV, or of treating a condition mediated by DPP-IV, which comprises administering a therapeutically effective amount of a compound according to claim 1 in free form or in pharmaceutically acceptable acid addition salt form to a patient in need of such treatment.





## ATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

dational Patent Classification 6: 67D 207/16, 401/12, 403/12, A61K

(11) International Publication Number:

WO 98/19998

31/40, 31/44, 31/505

(43) International Publication Date:

14 May 1998 (14.05.98)

(21) International Application Number:

PCT/EP97/06125

(22) International Filing Date:

5 November 1997 (05.11.97)

(30) Priority Data:

08/746,295

7 November 1996 (07.11.96)

US

(71) Applicant (for all designated States except US): NOVARTIS AG [CH/CH]; Schwarzwaldallee 215, CH-4058 Basel (CH).

(72) Inventor; and

(75) Inventor/Applicant (for US only): VILLHAUER, Edwin, Bernard [US/US]; 20 Dorothy Drive, Morristown, NJ 07960 (US).

(74) Agent: ROTH, Bernhard, M.; Novartis AG, Patent- und Markenabteilung, Lichtstrasse 35, CH-4002 Basel (CH).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, OH, HU, ID, IL, IS, IP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, KB, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SB), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(88) Date of publication of the international search report: 16 July 1998 (16.07.98)

### (54) Title: N-SUBSTITUTED 2-CYANOPYRROLIDINES

### (57) Abstract

N-(N'-substituted glycyl)-2-cyanopyrrolidines, e.g. the compounds of formula (I) wherein R has various significances, are novel. They inhibit DPP-IV (dipeptidyl-peptidase-IV) activity. They are therefore indicated for use as pharmaceuticals in inhibiting DPP-IV and in the treatment of conditions mediated by DPP-IV. such as non-insulin-dependent diabetes mellitus, arthritis, obesity, osteoporosis and further conditions of impaired glucose tolerance.









### FOR THE PURPOSES OF INFORMATION GIVLY

Codes used to Identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES.	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	PI	Finland	LT	Lidwania	SK	Slovakia
AT	Austria	FR	Prance	w	Luxembourg	SN	Scnegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijon	GB	United Kingdom	MC	Моласо	TD	Ched
BA	Bosnia and Horzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH -	Ghana	MG	Madaguscar	TJ	Tajikistan
BB	Belgium	GN	Ovinca	МK	The former Yugoslav	TM	Turkmenistan
BF	Burkina Paso	GR	Greece		Republic of Macedonia	TR	Turkey
BG	Bulgaria	HU	Hangary	ML	Mali	77	Trinklad and Tobago
BJ	Benin	18	freland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL.	Israel	MR	Mauritania	UO	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of Americ
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NB	Niger	VN	Vict Nam
CG	Congo	KB	Келуа	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	ю	Norway	ZW	Zimbabwo
CI	Côto d'Ivoire	KP .	Democratic People's	NZ	New Zealand		
СМ	Cumeroon		Republic of Korea	PL	Poland		
CN	China	KR	Republic of Korca	PT	Portugal		
CU	Cubs	ΚZ	Kazakstan	RO	Romania		
CZ	Czech Republic	ic	Saint Lucia	RU	Russian Federation		
DB	Germany	u	Liechtenstels	வ	Sudan		
DK	Denmark	LK	Sri Lanka	SE.	Sweden		
BE	Estonia	LR	Liberta	SG	Singspore		











## INTERNATIONAL SEARCH REPORT

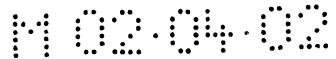
		PCT/EP 97	//06125		
A. CLASSII	FICATION OF SUBJECT MATTER C07D207/16 C07D401/12 C07D403/ A61K31/505	12 A61K31/40 A61K	(31/44		
According to	International Patent Classification (IPC) or to both national classificat	on and IPC	· · · · · · · · · · · · · · · · · · ·		
B. FIELDS					
Meramum 90 IPC 6	currentation seasoned (classification system followed by classification CO7D	n symbols)			
Documentat	non acaroned other than minimum documentation to the extent that sur	sh documents are included in the helds se	arched		
Electroma d	sta base consulted during the international search (name of data base	e and, where przoboal, sezroh terma used			
C. DOCUME	ENTS CONSIDERED TO BE RELEVANT		<del></del>		
Category *	Chatton of goodment, with indication, where appropriate, of the relevance	rant passages	Relevant to claim No.		
A	WO 90 12005 A (YOSHITOMI PHARMACE INDUSTRIES, LTD.) 18 October 1990 see page 39, compounds 19, 20, 22 see abstract	)	1,7		
A	EP 0 172 458 A (SUNTORY LTD.) 26 1986 see claims 1,4	February	1,7		
A	EP 0 115 639 A (HOECHST AG) 15 Au see claim 1	gust 1984	1		
<b>A</b>	EP 0 132 580 A (HOECHST AG) 13 Fe 1985 see page 10, line 30 - page 11, l	-	1		
		·			
Furt	ner documents are listed in line continuation of box C.	X Patent family members are fisted	in ennez.		
*Special estagores of sited documents:  "A" document defining the general state of the art which is not considered to be of particular relevance that one of the state of the art which is not considered to be of particular relevance that of the art which is not considered to be of particular relevance that of the state and not in conflict with the acclassion but cited to understand the principle or theory underlying the sweeton.  "A" document but published on or after the international thing date that the publication of the state and not in conflict with the acclassion or the sense of the state and not in conflict with the acclassion or the sense of the state and not in conflict with the acclassion or the sense of the state and not in conflict with the acclassion or the sense of the state and not in conflict with the acclassion or the state and not in conflict with the acclassion or the state of the state and not in conflict with the acclassion or the state of the art which is not an original to the sense of the state of the state and not in conflict with the acclassion or the state of the art which is not cred to understand the principle or theory underlying the or principle of the original to extend the principle or theory underlying the credit or principle or theory underlying the original to relate to the sense or theory underlying the original to relate the principle or theory underlying the original to relate the principle or theory underlying the original to extend to exceed the principle or theory underlying the original to original the principle or theory underlying the original to relate the principle or their the original treatment or the state and not in conflict with the acclassion or principle or theory underlying the original treatment or principle or the theory underlying the creating the principle or treatment or the consideration or annot be considered to move or annot be considered to worke an swentive step when the document is taken alone or annot be considered to exceed the original treatmen					
	ectual completion of the international search . May 1998	Date of making of the enterestance of 2.5, 05, 9			
Name and I	making address of the ISA European Patent Office, P.B., 5818 Patentinan 2 NL - 2280 HV Rijerijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Hass, C			











national application No.

INTERNATIONAL SEARCH REPORT PCT/EP 97/06125 Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet) This international Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons: 10 1. X Claims Nos.; because they relate to subject matter not required to be searched by this Authority, namely: Remark: Although claim 10 is directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition. because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful international Search can be carried out, specifically: Claims Nos.: 3. because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a). Box il Observations where unity of invention is lacking (Continuation of Item 2 of first sheet) This International Searching Authority found multiple inventions in this international application, as follows: As all required additional search less were timely paid by the applicant, this International Search Report covers all searchable claims. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee. As only some of the required additional search fees were timely paid by the applicant, this international Search Report covers only those claims for which less were paid, specifically claims Nos.; No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: The additional search less were accompanied by the applicant's protest Remark on Protest No protest accompanied the payment of additional search fees

Form PCT/ISA/210 (continuation of first sheet (1)) (July 1992)







### INTERNATIONAL SEARCH REPORT

information on patent family members

PCT/EP 97/06125

Patent docume cited in search re		Publication date	Patent family member(s)	Publication date
WO 9012005	Α	18-10-90	EP 0419683 A US 5118811 A	03-04-91 02-06-92
EP 172458	A	26-02-86	JP 1792858 C JP 4079334 B JP 61037764 A AU 575668 B AU 4559785 A US 4743616 A	14-10-93 15-12-92 22-02-86 04-08-88 06-02-86 10-05-88
EP 115639	A .	15-08-84	DE 3300316 A AU 575306 B AU 2314684 A CA 1220213 A CA 1235128 C DK 6384 A DK 33196 A FI 840027 A,B JP 1799960 C JP 5006542 B JP 59144755 A JP 1873839 C JP 5070423 A JP 5083541 B JP 1882520 C JP 5078312 A JP 6010190 B PT 77924 B US 4684662 A	12-07-84 28-07-88 12-07-84 07-04-87 12-04-88 08-07-84 21-03-96 08-07-84 12-11-93 26-01-93 18-08-84 26-09-94 23-03-93 26-11-93 10-11-94 30-03-93 09-02-94 30-05-86 04-08-87
EP 132580	A	13-02-85	DE 3322530 A CA 1224792 A DK 306684 A FI 842522 A JP 60013756 A PT 78756 B US 4691022 A	10-01-85 28-07-87 24-12-84 24-12-84 24-01-85 22-07-86 01-09-87

Form PCT/ISA/210 (palons turnly ennerg (July 1892)